Claims

1. An objective lens for an electron microscopy system with magnetic and electrostatic focusing for inspecting an object positionable in an object plane, comprising:

a pole shoe arrangement for generating a focusing magnetic field, which pole shoe arrangement is substantially rotationally symmetric about an optical axis of the objective lens extending in a z-direction and comprises an inner pole shoe and an outer pole shoe, wherein a pole shoe gap is formed between the inner and outer pole shoes at a lowermost position in z-direction of the inner pole shoe where the latter has a gap spacing oriented in z-direction from the outer pole shoe;

a coil body disposed in a space between the inner and the outer pole shoes; and

an electrode arrangement for generating a focusing electrostatic field, which electrode arrangement is substantially rotationally symmetric about the optical axis and comprises a beam tube which extends along the optical axis through the inner pole shoe and has a lower end, and a terminal electrode disposed spaced apart from the lower end of the beam tube,

wherein, in a region within at least 3 cm around the pole shoe gap, the following applies:

the inner pole shoe tapers downwards at least sectionally and has there an inner cone angle β and an outer cone angle χ in respect of the z-direction, the outer pole shoe extends conically downwards at least sectionally and has there an inner cone angle Δ and an outer cone angle α in respect of the z-direction,

and wherein the objective lens is configured such that a working distance between the terminal electrode and the object plane is smaller than 2 mm for electrons which pass through the beam tube at about 30 keV, and

wherein the following applies:

$30° < \alpha < 35°$ and $10° < \Delta\text{-}\chi < 14°$,

wherein

α represents the outer cone angle of the outer pole shoe

Δ represents the inner cone angle of the outer pole shoe and

χ represents the outer cone angle of the inner pole shoe.

2. The objective lens according to claim 1, wherein the outer pole shoe is delimited on the outside substantially by a cone surface with a cone angle α in respect of the z-direction, wherein the terminal electrode is delimited on the outside substantially by a cone surface with a cone angle α' in respect of the z-direction, wherein the terminal electrode is magnetically coupled without leaving a substantial gap to the outer pole shoe for reducing the magnetic field in the object plane.

3. The objective lens according to claim 1, wherein a distance A_1 between the lowermost position in z-direction of the inner pole shoe and the lower end of the beam tube is larger than 9 mm.

4. The objective lens according to claim 1, wherein the electrostatic field and the magnetic field overlap by less than 5%.

5. The objective lens according to claim 1, wherein the beam tube extends through an opening of the outer pole shoe formed by a lowermost region in z-direction of the outer pole shoe and the lower end of the beam tube is disposed spaced apart in z-direction from the opening of the outer pole shoe.

6. The objective lens according to claim 1, wherein the lower end of the beam tube comprises an end flange extending radially beyond an outer diameter of the beam tube.

7. The objective lens according to claim 6, wherein the end flange comprises a transition from a front face to a sheath section, wherein the transition is rounded in an axial cross-section, a radius of curvature of the rounding being more than 1 mm.

8. The objective lens according to claim 1, wherein a distance A_2 between the lower end of the beam tube and the lower end of the terminal electrode is larger than 3 mm.

9. The objective lens according to claim 1, wherein the terminal electrode tapers conically substantially up to a central opening in the terminal electrode.

10. The objective lens according to claim 9, wherein an inner diameter of the opening of the terminal electrode corresponds substantially to an inner diameter of the beam tube.

11. The objective lens according to claim 1, wherein the outer pole shoe tapers downwards.

12. The objective lens according to claim 1, wherein the gap spacing is larger than 3 mm.

13. The objective lens according to claim 1, wherein the inner pole shoe extends upwards as a cylinder sheath from its lower end over approximately 1 mm to 2 mm and is then conically enlarged.

14. The objective lens according to claim 1, wherein the inner pole shoe has an inner diameter of from 6 mm to 8 mm at its lower end.

15. An objective lens for an electron microscopy system with magnetic and electrostatic focusing for inspecting an object positionable in an object plane, comprising:

a pole shoe arrangement for generating a focusing magnetic field, which pole shoe arrangement is substantially rotationally symmetric about an optical axis of the objective lens extending in a z-direction and comprises an inner pole shoe and an outer pole shoe,

wherein a pole shoe gap is formed between the inner and outer pole shoes at a lowermost position in z-direction of the inner pole shoe where the latter has a gap spacing oriented in z-direction from the outer pole shoe;

a coil body disposed in a space between the inner and the outer pole shoes; and

an electrode arrangement for generating a focusing electrostatic field, which electrode arrangement is substantially rotationally symmetric about the optical axis and comprises a beam tube which extends along the optical axis through the inner pole shoe and has a lower end, and a terminal electrode disposed spaced apart from the lower end of the beam tube,

wherein the outer pole shoe is delimited on the outside substantially by a cone surface with a cone angle α in respect of the z-direction, wherein the terminal electrode is delimited on the outside substantially by a cone surface with a cone angle α' in respect of the z-direction, wherein the terminal electrode is magnetically coupled to the outer pole shoe whilst leaving an insubstantial gap therebetween, for reducing the magnetic field in the object plane.

16. The objective lens according to claim 15, wherein the objective lens is provided such that a working distance is smaller than 2 mm for electrons which pass through the beam tube at about 30 keV.

17. The objective lens according to claim 15, wherein a gap between the terminal electrode and the outer pole shoe is smaller than 0.6 mm, preferably, smaller than 0.2 mm.

18. The objective lens according to claim 15, wherein the surfaces of a region of the terminal electrode and a region of the outer pole shoe are opposed to each other.

19. The objective lens according to claim 15, wherein a distance A_1 between the lowermost position in z-direction of the inner pole shoe and the lower end of the beam tube is larger than 9 mm.

20. The objective lens according to claim 15, wherein the electrostatic field and the magnetic field overlap by less than 5%.

21. The objective lens according to claim 15, wherein the beam tube extends through an opening of the outer pole shoe formed by a lowermost region in z-direction of the outer pole shoe and the lower end of the beam tube is disposed spaced apart in z-direction from the opening of the outer pole shoe.

22. The objective lens according to claim 21, wherein the lower end of the beam tube comprises an end flange extending radially beyond an outer diameter of the beam tube.

23. The objective lens according to claim 22, wherein the end flange comprises a transition from a front face to a sheath section, wherein the transition is rounded in an axial cross-section, a radius of curvature of the rounding being more than 1 mm.

24. The objective lens according to claim 21, wherein a distance A_2 between the lower end of the beam tube and the lower end of the terminal electrode is larger than 3 mm.

25. The objective lens according to claim 15, wherein the terminal electrode tapers conically substantially up to a central opening in the terminal electrode.

26. The objective lens according to claim 25, wherein an inner diameter of the opening of the terminal electrode corresponds substantially to an inner diameter of the beam tube.

27. The objective lens according to claim 15, wherein the outer pole shoe tapers downwards.

28. The objective lens according to claim 15, wherein the gap spacing is larger than 3 mm.

29. The objective lens according to claim 15, wherein the inner pole shoe extends upwards as a cylinder sheath from its lower end over approximately 1 mm to 2 mm and is then conically enlarged.

30. The objective lens according to claim 15, wherein the inner pole shoe has an inner diameter of from 6 mm to 8 mm at its lower end.

31. An objective lens for an electron microscopy system with magnetic and electrostatic focusing for inspecting an object positionable in an object plane, comprising:

a pole shoe arrangement for generating a focusing magnetic field, which pole shoe arrangement is substantially rotationally symmetric about an optical axis of the objective lens extending in a z-direction and comprises an inner pole shoe and an outer pole shoe, wherein a pole shoe gap is formed between the inner and outer pole shoes at a lowermost position in z-direction of the inner pole shoe where the latter has a gap spacing oriented in z-direction from the outer pole shoe;

a coil body disposed in a space between the inner and the outer pole shoes; and

an electrode arrangement for generating a focusing electrostatic field, which electrode arrangement is substantially rotationally symmetric about the optical axis and comprises a beam tube which extends along the optical axis through the inner pole shoe and has a lower end, and a terminal electrode disposed spaced apart from the lower end of the beam tube,

wherein a distance A_1 between the lowermost position in z-direction of the inner pole shoe and the lower end of the beam tube is larger than 9 mm, in particular, larger than 10 mm.

32. The objective lens according to claim 31, wherein the distance A_1 between the lowermost position in z-direction of the inner pole shoe and the lower end of the beam tube is larger than 10 mm.

33. The objective lens according to claim 31, wherein the electrostatic field and the magnetic field overlap by less than 5%.

34. The objective lens according to claim 31, wherein the beam tube extends through an opening of the outer pole shoe formed by a lowermost region in z-direction of the outer pole shoe and the lower end of the beam tube is disposed spaced apart in z-direction from the opening of the outer pole shoe.

35. The objective lens according to claim 34, wherein the lower end of the beam tube comprises an end flange extending radially beyond an outer diameter of the beam tube.

36. The objective lens according to claim 35, wherein the end flange comprises a transition from a front face to a sheath section, wherein the transition is rounded in an axial cross-section, a radius of curvature of the rounding being more than 1 mm.

37. The objective lens according to claim 34, wherein a distance A_2 between the lower end of the beam tube and the lower end of the terminal electrode is larger than 3 mm.

38. The objective lens according to claim 31, wherein the terminal electrode tapers conically substantially up to a central opening in the terminal electrode.

39. The objective lens according to claim 38, wherein an inner diameter of the opening of the terminal electrode corresponds substantially to an inner diameter of the beam tube.

40. The objective lens according to claim 31, wherein the inner pole shoe extends upwards as a cylinder sheath from its lower end over approximately 1 mm to 2 mm and is then conically enlarged.

41. An examination system for observing and manipulating an object to be examined, comprising:

an electron microscopy system with an objective lens according to one of claims 1 to 40,

and an ion beam processing system for manipulating the object by means of an emitted ion beam,

an object support for holding and orienting the object in front of the ion beam processing system and the electron microscopy system by means of which a two-dimensionally extended object can be oriented in front of the electron microscopy system and the ion beam processing system such that the ion beam intersects the object surface orthogonally.

42. The examination system according to claim 41, wherein the object can be oriented in front of the electron microscopy system and the ion beam processing system such that the ion beam intersects the object surface at an angle deviating from the orthogonal up to about 2°.